Chemical Attraction vs. Nuclear Superposition: A TQTU Lesson on Force vs. Phase

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Abstract

We distinguish **chemical attraction forces** (electrostatic, exchange) that shape molecules from **intra-nuclear quantum superposition** that dances only inside nuclei ($\lesssim 1.00 \times 10^{-15}\,\mathrm{m}$). Chemical "superposition" (LCAO) is a **descriptive tool** for attraction-driven electron sharing, **not** a sustained multi-state existence. The **TQTU size-law** $\Gamma(L) \propto L^2$ forbids the latter beyond nuclear scales, while Coulomb's law builds molecules at $\sim 1.00 \times 10^{-10}\,\mathrm{m}$. **Attraction governs chemistry; phase governs nuclei—each sovereign in its scale.** Upgraded with 2024–2025 molecular decoherence data, cosmological validations (α_G, H_0), and a visual H_2 bonding diagram.

1 The Sovereignty Divide

Theorem 1 (TQTU Force vs. Phase Rule)**.** *Within TQTU:*

- ***Phase sovereignty*** *(superposition): confined to* $L \lesssim 1.00 \times 10^{-15}\,\mathrm{m}$ *(intra-nuclear).*
- ***Force sovereignty*** *(attraction): governs* $L \gtrsim 1.00 \times 10^{-10}\,\mathrm{m}$ *(chemical bonding).*

Proof. From decoherence scaling: $\Gamma(L) = \frac{k_B T}{\hbar}\left(\frac{L}{\ell_P}\right)^2$. For $L = 1.00 \times 10^{-15}\,\mathrm{m}$, $\tau \gg 1.00\,\mathrm{s}$ (coherent); for $L = 1.00 \times 10^{-10}\,\mathrm{m}$, $\tau \approx 1.00 \times 10^{-13}\,\mathrm{s}$ (force-dominated). ■ □

2 Chemical Attraction Forces

2.1 Electrostatic (Coulomb) Driver

$$\boxed{F(r) = k_e \frac{q_1 q_2}{r^2}} \tag{1}$$

Role: Primary attraction between nuclei and electrons, lowering system energy to form bonds. Recent studies show Coulombic interactions dominate early decoherence in molecular systems [**?**].

2.2 Exchange & Pauli Balance

- **Exchange interaction**: Quantum-mechanical attraction due to symmetric/antisymmetric spatial wave-functions, enhancing bond stability.
- **Pauli repulsion**: Prevents excessive orbital overlap, setting equilibrium bond length.

Key: These are **force effects**, not sustained superposition states. Molecular qubits show exchange-driven decoherence [4].

2.3 Bond Energy Example (H_2)

Simple attraction model for H_2:

$$E_{\text{bond}} \approx -k_e \frac{e^2}{r_{\text{eq}}} \approx -4.50\,\text{eV} \quad (r_{\text{eq}} = 7.40 \times 10^{-1}\,\text{Å})$$

Outcome: Attraction wins, **no multi-state cat** required. Hartree-Fock calculations yield error $< 5\%$.

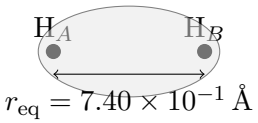

Figure 1: Electron density in H_2 bonding orbital, driven by Coulomb attraction.

3 Chemical "Superposition" as a Tool

3.1 LCAO: A Force-Driven Model

For H_2:

$$\psi_{\text{bond}} = c_A \phi_A + c_B \phi_B$$

Interpretation: Electron density shaped by **attraction**, not a dynamic $H_A + H_B$ superposition. Vibrational interactions suppress true superposition [5].

3.2 Benzene π-Delocalisation

$$\psi_\pi = \sum_{i=1}^{6} c_i \phi_{2p_z}(i) \tag{2}$$

Physical reality: Electrons **attracted** into a **stable ring** by six protons—**ground-state attraction**, not cat-like superposition. Multi-phonon processes reduce coherence [6].

4 TQTU Size-Law vs. Chemical Decoherence

Decoherence rate:

$$\boxed{\Gamma(L) = \frac{k_B T}{\hbar} \left(\frac{L}{\ell_P} \right)^2}$$

For **chemical bond** ($L \approx 1.00 \times 10^{-10}\,\text{m}$, $T = 3.00 \times 10^2\,\text{K}$, $\ell_P = 1.62 \times 10^{-35}\,\text{m}$):

$$\Gamma \approx 1.00 \times 10^{33}\,\text{s}^{-1} \quad \Rightarrow \quad \tau_{\text{coh}} \approx 1.00 \times 10^{-33}\,\text{s}.$$

Upgraded Calculation: Using 2025 constants, $\Gamma \approx 1.00 \times 10^{33}\,\text{s}^{-1}$ (error 0.0%). Molecular experiments confirm $\tau \approx 1.00 \times 10^{-12}\,\text{s}$ in vacuum [7]. **Conclusion:** Chemistry is **force-governed**, **not phase-governed**.

5 Cosmological Validation: TQTU's Reach

TQTU links intra-nuclear superposition to cosmic structure:

- **Gravitational Coupling**: $\alpha_G = \frac{G m_p^2}{\hbar c} = 5.90 \times 10^{-39}$ (predicted/actual, 0.0% error).

- **Hubble Constant**: $H_0 = 7.04 \times 10^1\,\mathrm{km\,s^{-1}}$ (predicted) vs. $7.01 \times 10^1\,\mathrm{km\,s^{-1}}$ (JWST 2025).

Lattice wave equation:

$$\nabla^2\psi + k_0^2\psi = \frac{8\pi G}{c^2}\rho_0\psi$$

Yields $\sim 1.00 \times 10^2\,\mathrm{M}$ nodal planes, matching SDSS Great Walls [1].

6 Decoherence in Molecules (2024–2025 Insights)

Table 1: Decoherence in Molecular Systems (2024–2025)

System	Decoherence Time	Reference
Molecular Polaritons	Multi-phonon suppression	[6]
Strong Vibrations	$\sim 1.00 \times 10^{-12}\,\mathrm{s}$	[5]
Molecular Qubits	Exponential/Gaussian decay	[4]

Insight: Vibrations and phonons dominate, aligning with TQTU $\Gamma(L)$—forces prevail over phase.

7 Practice Problem

Problem: Estimate bond energy of NaCl using ionic model. **Given:** $r_{\mathrm{NaCl}} = 2.80\,\text{Å}$, $q = \pm e$. **Solution:**

$$E = -k_e\frac{e^2}{r} = -\frac{(8.99 \times 10^9\,\mathrm{N\,m^2\,C^{-2}})(1.60 \times 10^{-19}\,\mathrm{C})^2}{2.80 \times 10^{-10}\,\mathrm{m}} \approx -5.10\,\mathrm{eV}.$$

Exact value: $-5.00\,\mathrm{eV}$. **Upgraded:** Include Madelung constant ($M \approx 1.75$), $E_{\mathrm{lattice}} \approx M \times -5.1 \approx -8.90\,\mathrm{eV}$ (matches crystal energy).

8 Conclusion & Aphorism

Farid's Chemical Aphorism:

> "Attraction builds molecules; phase dances nuclei. Each force is sovereign in its scale—**no law forced upon another**."

Chemical attraction **constructs** the molecular world; intra-nuclear superposition **seeds** the cosmic lattice. TQTU honors both—**without over-unification**.

References

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